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Reducing Carbon Footprint And Enhancing Sustainability Via Imprint Technology Using Mordanting Techniques On Cotton Fabric Printing With Flower And Leaf

(Pre-Mordant and Post-Mordant)

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Abstract: Clothing serves several essential functions, including protection, identification, and adornment. Among the methods used to enhance fabrics, printing techniques play a significant role, while conventional techniques like screen printing and block printing are still commonly used. Recently, eco-printing has emerged as a contemporary and sustainable technique that utilizes plant materials to create unique colors and patterns on textiles. Mordants, particularly a few Natural Mordants are critical in this process as they enhance and improve color quality with changes in the natural pigment of the flower & leaf and base colour of the fabric, resulting in unexpected results. This study aims to investigate the effects of pre-mordanting and post-mordanting on the color quality, shape, depth, fastness properties, and overall aesthetics of cotton fabrics printed with natural dyes derived from flowers and leaves. Flower and leaf impression printing, also known as floral impressionism or pounding, is an innovative technique that uses the natural shapes and colors of flowers to create unique prints on fabric. This eco-friendly method involves pressing fresh flowers or leaves into cloth, either by hand or using a hammer for the printing press, to transfer their intricate patterns and vibrant hues. As the textile industry faces scrutiny for its significant environmental impact, adopting sustainable practices like flower & leaf impression printing can revolutionize fabric printing and reduce pollution.

Few benefits of Natural Printing, which contribute to both the environment and Design Aesthetics are 1. Eco-Friendly Process,2. Sustainable Fabrics,3. Minimal Waste, 4. Unique Aesthetic,5. Promoting Awareness, 6.Innovative.

Index Terms **– Sustainable, Natural Printing, Carbon footprint reduction, Innovative, Chemical free.**

INTRODUCTION

Flower and leaf impression printing, also known as floral impressionism or pounding, is an innovative technique that uses the natural shapes and colors of flowers to create unique prints on fabric. This eco-friendly method involves pressing fresh flowers or leaves into cloth, either by hand or using a hammer for the printing press, to transfer their intricate patterns and vibrant hues. As the textile industry faces scrutiny for its significant environmental impact, adopting sustainable practices like flower & leaf impression printing can revolutionize fabric printing and reduce pollution.

Environmental Impact of the Textile Industry

The Textile Industry's impact on the environment is one of the worst polluters in the world; the textile sector causes serious water pollution and soil contamination through the discharge of synthetic dye waste and the accumulation of synthetic fabric in landfills. These pollutants threaten aquatic ecosystems and human health. To combat these issues, there is a pressing need for sustainable manufacturing practices that prioritize environmental health.

ECO-PRINTING: AN OVERVIEW

Eco-printing is a method that uses various parts of plants to create prints on fabric. This technique extracts pigments directly from the plant materials, allowing for unique and organic designs. The two most practiced methods of eco-printing are:

1. **Bind and Steam Technique**: In this method, different plant parts are arranged and bound between layers of fabric. The layers are then steamed to transfer the pigments onto the fabric, resulting in distinct and vibrant prints.
2. **Hammering or Pounding Technique**: This technique involves beating the plant material with a soft hammer directly onto the fabric. After the pigments are released, the fabric is wrapped and steamed to set the prints, creating rich and intricate designs.

Benefits of Impression Printing

1. **Eco-Friendly Process**:
   - Flower impression printing utilizes non-toxic, biodegradable materials. Most flowers are safe for human consumption and are often used in food and medicinal products, making them an ideal choice for sustainable dyeing.
2. **Sustainable Fabrics**:
   - This printing technique can be applied to natural, sustainable fabrics such as organic cotton, linen, or hemp, which are biodegradable and have a lower environmental footprint compared to synthetic textiles.
3. **Minimal Waste**:
   - By using fresh flowers, the process generates minimal waste, and any leftover plant materials can be composted, further supporting ecological balance.
4. **Unique Aesthetic**:
   - Each print is unique, capturing the intricate details of the flowers used, which adds a personalized touch to textile products. This individuality appeals to consumers looking for distinctive, artisanal items.
5. **Promoting Awareness**:
   - By showcasing the beauty of flowers and the potential for eco-friendly printing, this technique can raise awareness about sustainable practices and encourage more environmentally conscious consumer choices.

MATERIALS AND METHODS

1. Fabric

In this study, Cotton Scoured & Bleached fabrics were utilized:

- Domestic cotton with a thread count of 144. The thickness of the fabrics was measured using a Paramount thickness tester to ensure consistency in the material used for eco-printing.

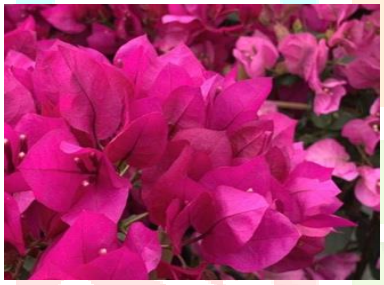
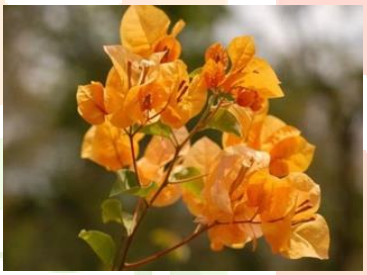
2. Plant Material

This study was about the printing substance for-

Hong Kong, also known as Bauhinia X Blakeana orchid trees. In this study, three varieties of this flower were used, one of which was light pink and another with purple and white flowers. It's a hybrid leguminous tree of the Genus Bauhinia.



Bougainvillea Glabra is a sharp, evergreen plant that climbs vigorously. two colours are 8 available in dark pink, purple, and orange. Flowers and leaves are used to develop the prints, and flowers of purple and pink are used mainly for the print.


Rosa x Damascena, also called the Damask rose, is a hybrid rose that descended from Rosa gallica and Rosa moschata. It is occasionally referred to as the Bulgarian rose, Turkish rose, Taif rose, Arab rose, Ispahan rose, and Castile rose. Flower petals and Green leaves are used to develop prints.

Sesbania grandiflora a known Sesbania grandiflora, is the scientific name for agathi keerai in Tamil, whereas August tree leaves or hummingbird tree leaves are the English names for the spinach type. Agathi leaves come in two types. One type has white flowers, while another, known as red August tree leaves, has red flowers. Flowers in red and leaves are used in printing to obtain the print.



Tagetes patula, the French marigold, or Tagetes patula, is a daisy-family flowering plant that is indigenous to Mexico and Guatemala and has established naturalised populations in numerous other nations. It is commonly grown as an With thousands of varieties in vibrant orange and yellow hues, this bedding plant is simple to grow. Marigold is utilised as a trap crop in the borders to draw insects that are attacking the main crop.

Alternanthera is a genus of flowering plants belonging to the Amaranthaceae family is Alternanthera. The majority of the species of this widely distributed genus are found in the tropical Americas. However, some can be found in Asia, Africa, and Australia. The genus' plants are commonly referred to as Joseph's coat or joyweeds.

This study aims to repurpose these discarded flowers and leaves for textile printing, highlighting their potential as a sustainable resource.

3. Mordant

Both the pre-mordanting and post-mordanting procedures used **Aluminium potassium sulphate**, also known as alum, as a mordant. Alum is a sensible option for eco-printing because it is widely available, reasonably priced, and abundant. It is also regarded as a safe mordant. Because of their strong affinity for cellulosic (cotton) fibres, the aluminium ions found in alum serve as a bridge between the dye molecules and the fibres, improving colour retention and print quality overall. Another Mordant used is **Copper Sulphate.** It is used in natural dyeing to enhance the color of dyes and improve their light and wash fastness. Copper sulfate can bring out blue and green hues in natural dyes and intensify yellow dyes. It can also darken dye colors, similar to tin, but is less harsh.

METHODOLOGY OVERVIEW

1. Fabric Preparation Before Printing

1. 100% cambric cotton was scoured and bleached to remove impurities and prepare it for dye absorption.
2. The fabric was then treated with natural mordant: **Aluminium Potassium Sulphate.**

2. Mordanting Process:

Pre-Mordanting: The fabrics were treated with a solution of Aluminium Potassium Sulphate before dyeing, allowing the mordant to bond with the fibers. The scoured and bleached fabric was soaked in a 5% solution of mordant (based on the weight of the fabric) in hot water for 3-4 hours.

After soaking, the fabric was removed from the solution, rinsed in cold water, and dried in the shade. Samples measuring 12 cm x 6 cm were cut from the mordanted fabrics and set aside for printing.

To use **copper sulfate as a mordant**, weigh copper sulfate as per the weight of the fabric/sample. Dissolve copper sulphate in hot water. Top off with cold water to cover the fabric. Let the fabric sit in the mixture overnight, stirring in between. Alternatively, heat the solution for 1–2 hours to below a simmer.

Post-Mordanting: After the printing process, the fabrics were immersed in the mordant solution to enhance color adherence.(For both Copper Sulphate and Aluminium Potassium Sulphate).

3. Eco-Printing Procedure:

- Fresh flowers and leaves were arranged on the prepared fabric. Depending on the technique employed, either the bind and steam or hammering method was used to transfer the pigments from the leaves onto the fabric.
- The printed fabrics were then steamed to set the colors and enhance the print clarity.

Requirements for Printing

- Pre-mordanted fabric samples
- Freshly picked flowers and leaves (ensuring none are toxic)
- Hammer (iron or wooden)
- Plastic transparency sheet (A5 size)
- Masking tape (1 inch)
- Scissors
- Printing table with felt bedding
- Rough cloth

METHOD OF PRINTING

Printing can be performed using two main techniques:

1. **Direct Printing**
2. **Fabric Fold Printing**

Procedure:

Lay the pre-mordanted and post-mordanted fabric on the printing table. Arrange the flowers and leaves according to the chosen printing method to create a desired design.

For Direct Printing:

- Place the flowers and leaves in a pattern on the fabric.
- Secure them in place using masking tape to prevent movement during the printing process, ensuring the fabric absorbs the plant pigments effectively. This method results in a print on only one side of the fabric.

For Fabric Fold Printing:

- Arrange the flowers and leaves on one half of the fabric, leaving the other half empty.
- Fold the empty half over the designed half to cover it.
- Place a transparency sheet over the fabric and secure it with masking tape to prevent movement. This method allows for prints on both sides of the fabric, creating a mirror image effect.

1. **Hammering**: Gently hammer the arranged plant material to release the pigments. Use a light hand to avoid damaging the flowers and leaves but ensure thorough contact to achieve desired results.
2. **Resting Period**: Allow the printed fabric to rest for at least 1 hour, enabling the flowers and leaves to release their pigments onto the fabric.
3. **Final Steps**:
   - Carefully remove the masking tape from the direct print samples after the resting period and allow the samples to dry completely.
   - For color fixation, various trials will be conducted following the printing process.

Testing: The resulting prints were subjected to various tests for colorfastness and overall quality, shape, depth, and quality of prints, ensuring they meet desired standards.

RESULT AND DISCUSSION

The effect of mordant on colour, shape, depth and quality of Prints

Flowers & leaf	Sharpness of Outline	Evenness of Print	Depth of Shade	Aesthetic Appeal	Image Unwashed Sample	Image washed Sample	Overall Grading (color fastness to washing)	Type of fabric Bleached & Unbleached	Name & % of mordant used	Type of Mordanting
1. Rosa X Damascena 2. Bauhinia X Blakeana 3. Solanum Tuberosum	3.94	3.19	3.13	3.94			4	Cotton Scoured & Bleached	5% Aluminium potassium Sulphate	Post Mordanting
1. Bauhinia X Blakeana 2.Tagetes Patula 3. Alternanthera Green	3.06	3.25	3.44	3.44			3	Cotton Scoured & Bleached	5% Aluminium potassium Sulphate	Pre Mordanting
1.Asparagus 2.Bauhinia X Blakeana 3.Tagetes patula	3.00	2.69	3.13	3.13			2/3	Cotton Scoured & Bleached	5% & 15% Aluminium potassium Sulphate	Pre & Post Mordanting
1.Rosa x damascene 2.Senna marileandica 3.Alternanthera(green)	3	2.5	3.5	3			3	Cotton Scoured & Bleached	5% & 15% Copper sulphate	Pre & Post Mordanting
1. Bougainvillea glabra 2.solanum tuberrosum 3.Alternanthera	3.44	3	3.5	3			3	Cotton Scoured & Bleached	5% Copper Sulphate	Pre Mordanting
1.Alternanthera 2.Tagetes Patula	3	2.95	4	3			4	Cotton Scoured & Bleached	5% Copper Sulphate	Post Mordanting

In this study the colour fastness has been evaluated for the prints derived from flowers and leaves on cotton bleached fabric using different pre- and post-mordanting techniques. specifically, Rosa x damascena, Bauhinia x blakeana, Alternanthera, Tagetes Patula and Solanum tuberosum were found overall with very good results as compared to others(Bougainvillea glabra and Asparagus). The findings indicate that the cotton

bleached fabric mordanted with the Alluminuim Potassium Sulphate & Copper Sulphate exhibited strong colorfastness across various tests, achieving scores of 4-5 on the gray scale for dry cleaning, washing, perspiration, and crocking. However, the fabric showed average colorfastness to sunlight, with a score of 3. (**Note-** There is colour change from Brown to Olive green(Alternanthera leaves) when post Mordanting with Copper Sulphate is done.)

CONCLUSION

Eco-printing on textiles highlights its accessibility and affordability, making it an attractive method for home crafters. It is noted that while there are various plants, mordants, and fabrics available for eco-printing, the challenge lies in the colorfastness of prints developed, with a lack of documented data on this property. Applying both pre- and post-mordanting with alum seems to effectively enhance colorfastness, suggesting a way to standardize the process. Even Application of Pre- and Post- Mordanting with Copper sulphate seems to enhance the colour fastness but also leads to colour change of the print developed due to its natural colour green, so it is suggested that the copper sulphate when used as mordant should be used carefully with the light pigmented flowers as it will darken or change the tint of the original colour.

This conclusion positions eco-printing as not only a sustainable option for textile decoration but also a viable one that can yield more durable results when proper techniques are used.

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